# State of the Practice: DNAPL Source Zone Treatment

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**Background/Objectives.** The art and science of DNAPL source zone practice has changed significantly over time. When the "DNAPL paradigm" emerged from Dr. John Cherry's and other research groups in the late 1980s, it answered some key questions on why pump and treat systems were unable to reach low part per billion cleanup standards and why chlorinated solvent plumes were so persistent. The DNAPL paradigm quickly took hold in the groundwater cleanup community and lead to an age of innovation where a series of ingenious in-situ remediation technologies were invented, developed, and then became standard practice. These in-situ remediation technologies, comprised of thermal, chemical, biological, and other processes, became the industry norm as thousands of in situ DNAPL source zone remediation projects were implemented from the 1990s to today.

However, several remediation performance studies, most funded by the U.S. Dept. of Defense ESTCP program, indicated there were limits on what these in situ remediation technologies can do. A new paradigm began to emerge, where the definition of the DNAPL source zone evolved from "where the DNAPL is present" to "where the DNAPL is *or was* present" to account for pernicious matrix diffusion effects. The remediation community is now grappling with this new challenge – removing or managing contaminants from low permeability media within a DNAPL source zone, and has lead to another round of innovation, invention, and inspiration regarding DNAPL source zone treatment.

**Approach/Activities.** This state of the practice talk will review the history of DNAPL source zone treatment, give the author's perspective on where we are today, and then speculate on where we might go in the future.

**Results/Lessons Learned.** A 2013 U.S. State-of-the-Science review funded by SERDP (Sale et al., 2013) considered the challenges of contaminants stored in low permeability media at DNAPL sites and developed a "top 10 list" of key implications for DNAPL source zone treatment: *Amendments are More Difficult to Apply in Low k Units; Thermal Processes Have a Theoretical Advantage, But…; Destroying the Heterogeneity Works; Interfaces and Targeted Treatment; These are Nonpoint Sources; Containment, Perhaps in Different Forms, Makes a Comeback; It is Important to Know if Your Site is In Its Early, Middle, or Late Stage; This is a Management and Regulatory Problem Tool; What is the Objective?; and Don't Underestimate Human Ingenuity.*
These implications, together with the following questions will be discussed:

- Is matrix diffusion is the "revenge of the geologists"?
- Can the geotechnical field help us with their cool technologies and their big machines?
- Measuring Natural source zone depletion (NSZD) is all the rage in the LNAPL world – can their technologies work in the DNAPL world?
- How can we better manage large and dilute plumes from DNAPL source zones?
- Does dioxane and PFAS co-contaminants change our perspective about DNAPL source zones?
- How far in the future should we look when making decisions about DNAPL source treatment?
- How many DNAPL source zone remediation projects are successful?